Davis-Besse Reactor Vessel Head Damage
NRC UPDATE

August 2003

This is the twelfth periodic update on the NRC response to the reactor vessel head damage at the Davis-Besse Nuclear Power Station. The updates will be available at public meetings of the NRC Davis-Besse Oversight Panel which is coordinating the agency's activities related to the damage. Each update will include background information to assist the reader in understanding issues associated with the corrosion damage.

Pumps being reinstalled to perform reactor test

FirstEnergy is reinstalling its two high pressure injection pumps to allow it to perform a seven-day test of the reactor cooling system. The pumps had been temporarily removed for testing and possible modification to correct a design problem found by the utility. These pumps would provide cooling water to the reactor during a loss of coolant accident in which the pressure in the reactor remained high. Other pumps would be available at lower reactor pressures.

The seven-day test of the reactor cooling system is intended to make certain there are no leaks, particularly associated with the new reactor head installation and where tubes pass through the bottom of the reactor. The reactor will not be started up for the test; heat added through the operation of the reactor cooling pumps will be sufficient to reach normal operating pressure and approach normal operating temperature.

The NRC Oversight Panel is discussing with FirstEnergy the testing methods that will be used to measure possible leakage during and following the test. When the test is conducted, the NRC will observe the activities and evaluate the results of the test.

Because of the unresolved high pressure injection pump design problem, FirstEnergy must obtain NRC approval to conduct the test prior to modifying the pumps. The utility has submitted data to show that the heat generated by the reactor, which has not operated for 18 months, would not require long term operation of the high pressure pumps even in the event of a pipe break.

Ongoing and Planned NRC Inspections

The NRC has a series of inspections planned before any decision on whether or not the Davis-Besse plant may resume operations. These inspections include:

- **Ongoing -** Management and Human Performance, Phase III (Safety Culture) - This inspection focuses on FENOC's actions to improve management effectiveness and human performance and its processes to survey and assess the safety culture among the staff at Davis-Besse – how the management and workers will identify and deal with safety concerns.
- **Ongoing** - Corrective Action Team Inspection - This inspection looks at the effectiveness of the corrective action program at Davis-Besse – how the utility finds, evaluates, and fixes problems.
- **Ongoing -** Safety System Design Reviews - The utility's Systems Health verification program and earlier NRC inspections had found potential design questions that needed to be resolved. This inspection will look at the effectiveness of the design reviews.
- **Planned -** Reactor Cooling System Test (Normal Operating Pressure) - This inspection will monitor the plant's test of the reactor vessel and associated piping to assure there are no leaks in the system.
- **Planned -** Restart Assessment Team - As the utility nears the point where it will seek NRC authorization for restart, this team inspection will thoroughly review the readiness of the plant and the plant staff to resume plant operations safely and in compliance with NRC requirements.

After the seven-day test is completed, the utility will remove the two high pressure pumps and modify them, incorporating a design which has been applied to similar pumps in French nuclear power plants and other improvements. The modification would prevent damage to the pump components from debris that may be present in the water.

The utility will present its plans for the modification to the NRC in a meeting in the NRC headquarters in Rockville, Maryland. The date has not been set. Once scheduled, the details of the meeting will be available on the NRC web site.

In addition to the high pressure injection pumps, the NRC is monitoring another issue found by FirstEnergy during its extensive design and functional reviews of important plant safety systems. Deficiencies were found in the analysis of whether the plant's electrical distribution system provided the necessary minimum voltage to safety equipment throughout the plant. The electrical distribution analyses are being updated and modifications are planned before possible restart of the plant.

Mail Call

In the past weeks, the NRC has received more than 2000 letters and 400 e-mails from members of the public in Ohio and other areas expressing their interest and concern about Davis-Besse. The agency will respond to all the individual letters and e-mails sent in by interested members of the public.

NRC Issues Report on DB's Corrective Actions to Address Safety Culture Problems

On July 24, the NRC issued a report which details the NRC's review of FirstEnergy's activities to identify and correct management and human performance deficiencies which led to the reactor vessel head degradation. The review also included the plant staff's evaluation of the root cause assessment methods and the appropriateness of the corrective actions.

NRC inspectors concluded that the company's assessment of the management and human performance deficiencies which led to the reactor vessel head degradation was appropriate and sufficiently broad enough to develop corrective actions necessary to address these problems. NRC inspectors also found that the utility appropriately scheduled and implemented these corrective actions.

However, while the corrective actions may be acceptable to address the restart checklist item, additional activities appear to be necessary to sustain the improvements in the safety culture at Davis-Besse. The NRC plans to hold a public meeting with FirstEnergy to discuss its long-term plans to address safety culture issues.

The NRC team is continuing its review of FirstEnergy's efforts to evaluate and improve the safety culture at the Davis-Besse plant. This review includes the utility's program to foster a "safety conscious work environment" in which workers feel free to raise safety issues without fear of retaliation.

The remaining inspection activities are (1) review of the process for the plant's internal assessment of safety culture; (2) observation of the activities of the plant's Safety Conscious Work Environment Review Team; and (3) review of FirstEnergy's plan for long-term improvement actions and assessment of plant staff safety culture. As part of the continuing inspection, the NRC inspectors observed FirstEnergy's third internal safety culture assessment, which evaluated (1) policy or corporate commitment to safety (2) plant management commitment to safety and (3) individual commitment to safety. The results of these reviews will be detailed in the final report on Davis-Besse's safety culture.

Preliminary containment sump problem safety significance: 'yellow'

The NRC has completed its review of the potential clogging of the containment sump during a possible accident at the Davis-Besse Nuclear Power Station and made the preliminary determination that it was a "yellow" finding. NRC inspection findings are evaluated using a four-level scale of safety significance, ranging from "green" for a finding of minor significance, through "white" and "yellow" to "red," for a finding of high safety significance. A yellow finding is one of substantial safety significance..

The NRC inspection found that there was improper coating material, fibrous material, and other debris in the reactor containment that could obstruct the flow of water into the containment sump in the unlikely event of an accident. To provide continued long-term cooling of the reactor following a loss-of-coolant accident, water would drain into the sump and be pumped back into the reactor. The buildup of debris on the screen for the reactor sump could restrict the flow of water for reactor cooling.

The NRC findings are contained in Inspection Report No. 50-346/03-15, which was issued on July 30. It is available on the NRC web site: http://www.nrc.gov -- select "Davis Besse" from the list of key topics. The inspection report is on the "News and Correspondence" page.

FirstEnergy discovered the potential clogging problem during its safety system design reviews last year. To correct the problem, it has installed a redesigned sump screen, providing substantially larger surface area, and, in addition, recoated surfaces in the containment with approved coatings and removed other sources of debris. In a previous inspection report (No. 50-346/03-06), issued in June, the NRC concluded that the design and installation of the modified sump screens were satisfactory.

Normally, yellow findings can lead to additional NRC inspections and meetings with the utility. In the case of Davis-Besse, however, the plant is already subject to intense scrutiny, and the NRC oversight panel is monitoring the plant's activities and meeting frequently with the utility.

Three NRC inspection reports issued

Three inspection reports were issued recently and posted to the NRC's web site at http://www.nrc.gov - select 'Davis-Besse' from the key topics menu. The reports are on the 'news and correspondence' page.

- **Integrated Containment Leak Rate Test** - (Report No. 50-346/03-08) issued August 6. This inspection monitored the testing by the plant staff of the reactor containment to assure that it meets the NRC requirements for "leak-tightness" of the containment. No findings of significance were identified.

- **Resident Inspectors' Report -** (Report No 50-346/03-15) issued July 30. This report includes the safety significance evaluation of the containment sump problem, discussed on Page 3, and, in addition, discusses the high pressure injection pump issue, described on Page 1. The NRC staff is continuing its review of the high pressure injection pump issue to determine its safety significance.

- **Management and Human Performance, Phase II (Safety Culture)** - (Report No 50-346/02-18) issued July 24. This inspection focused on the work underway to survey and assess the safety culture among the staff at Davis-Besse – how the management and workers deal with safety concerns. See additional details on Page 2.

Next Davis-Besse Oversight Panel Meetings - 2 p.m. and 7 p.m. - Wed., Sept. 10
Oak Harbor High School Auditorium - 11661 West State Route 163, Oak Harbor

Investigation continues into FirstEnergy's handling of corrosion issue

The NRC's investigation into whether Davis-Besse deliberately withheld or provided false or incomplete information to the NRC on the circumstances surrounding the reactor vessel head corrosion continues. Although the details of the NRC's investigation cannot be discussed publically, the NRC's Oversight Panel maintains close, continuous communication with the NRC's Office of Investigations, which is conducting the investigation. The Oversight Panel will not make a recommendation for the plant's restart until it is confident that the issues under investigation have been properly addressed.

Davis-Besse Restart Checklist

The Oversight Panel has created a "restart checklist" categorizing 31 actions in seven major areas which FirstEnergy needs to complete before the NRC can consider making a decision on whether Davis-Besse may restart. The NRC oversight panel has determined that the utility has adequately completed sixteen of those actions.

NRC inspections are directed at evaluating the checklist items as well as reviewing the ongoing work at Davis-Besse.

The completed items are shown in italics and have a check mark in front of the item. For the completed items, the list also includes the inspection report which documents the NRC's review of the item.

1. **Adequacy of Root Cause Determinations**
- ✔ *1.a Penetration Cracking and Reactor Pressure Vessel Corrosion* (Report No. 50-346/03-04)
- ✔ *1.b Organizational, Programmatic and Human Performance Issues* (Report No. 50-346/02-18)

2. **Adequacy of Safety Significant Structures, Systems, and Components**
- 2.a Reactor Pressure Vessel Head Replacement
- ✔ *2.b Containment Vessel Restoration Following Reactor Pressure Vessel Head Replacement* (Report No. 50-346/03-08)
- 2.c Structures, Systems, and Components Inside Containment
  - 2.c.1 Emergency Core Cooling System and Containment Spray System Sump
- 2.d Extent-of-Condition of Boric Acid in Systems Outside Containment
- 2.e High Pressure Injection Pump Internal Clearance/Debris Resolution

3. **Adequacy of Safety Significant Programs**
- 3.a Corrective Action Program
- ✔ *3.b Operating Experience Program* (Report No. 50-346/03-09)
- 3.c Quality Audits and Self-Assessments of Programs
- ✔ *3.d Boric Acid Corrosion Management Program* (Report No. 50-346/03-17 - to be issued)
- ✔ *3.e Reactor Coolant System Unidentified Leakage Monitoring Program* (Report No. 50-346/03-09)
- ✔ *3.f In-Service Inspection Program* (Report No. 50-346/03-09)
- ✔ *3.g Modification Control Program* (Report No. 50-346/03-09)
- ✔ *3.h Radiation Protection Program* (Report No. 50-346/03-17 - to be issued)
- 3.i Process for Ensuring Completeness and Accuracy of Required Records and Submittals to the NRC

4. **Adequacy of Organizational Effectiveness and Human Performance**
- ✔ *4.a Adequacy of Corrective Action Plan* (Report No. 50-346/02-18)
- 4.b Effectiveness of Corrective Actions

5. **Readiness for Restart**
- 5.a Review of Licensee's Restart Action Plan
- 5.b Systems Readiness for Restart
- 5.c Operations Readiness for Restart

5.d Test Program Development and Implementation

6. **Licensing Issue Resolution** (Not discussed in inspection reports)

✔ *6.a Verification that Relief Requests A8 and A12 regarding the Shell to Flange Weld (previously submitted by letter dated September 19, 2000) is not Impacted by the Midland RPV Head*

✔ *6.b American Society of Mechanical Engineers (ASME) Code Relief Request for Failure to Maintain Original Radiographic Tests of the Midland Head to Flange Weld (Planned Relief Request A26)*

✔ *6.c ASME Code Relief Request for Inability to Radiographically Test 100% of the Midland Reactor Pressure Vessel Head to Flange Weld (Planned Relief Request A27)*

✔ *6.d Resubmit Relief Request A2 (previously submitted by letter dated September 19, 2000) for ASME Code for Inability to Perform 100% volumetric and surface examination of Head to Flange Weld*

✔ *6.e Reconciliation Letter that Demonstrates How the New Reactor Pressure Vessel Head Correlates With the ASME Code and QA Index for Section III and Section XI - Commitments*

✔ *6.f Verification Letter of Technical Specification Pressure/Temperature Curves for New Vessel Head - Commitment*

6.g Request to relocate High Pressure Injection and Low Pressure Injection Subsystems Flow Balance Testing from Technical Specifications 4.5.2.h to Updated Safety Analysis Report Technical Requirements Manual

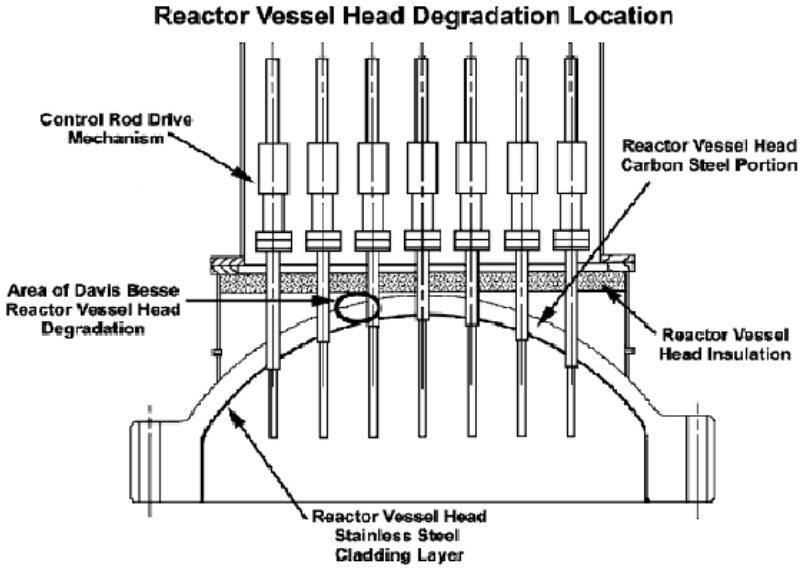
7. **Confirmatory Action Letter Resolution**

7.a Verification that Confirmatory Action Letter Items are Resolved, Including a Public Meeting to Discuss Readiness for Restart

Background Summary: What Happened at Davis-Besse

In March 2002 plant workers discovered a cavity in the head or top of the reactor vessel while they were repairing control rod tubes which pass through the head. The tubes, which pass through the reactor vessel head, are called control rod drive mechanism nozzles. Cracks were detected in 5 of the 69 nozzles. In three of those nozzles, the cracks were all the way through the nozzle, allowing leakage of reactor cooling water, which contains boric acid.

Corrosion, caused by the boric acid, damaged the vessel head next to Nozzle No. 3, creating an irregular cavity about 4 inches by 5 inches and approximately 6 inches deep. The cavity penetrated the carbon steel portion of the vessel head, leaving only the stainless steel lining. The liner thickness varies somewhat with a minimum design thickness of 1/8 inch. Subsequent examination by Framatome, FirstEnergy's contractor, found evidence of a series of cracks in the liner, none of which was entirely through the liner wall.



After circumferential cracks - around the nozzle wall - were found in the control rod drive nozzles at Unit 3 of the Oconee Nuclear Power Station in 2001, the NRC required all pressurized water reactor (PWR) operators to report to the NRC on structural integrity of the nozzles and their plans to inspect the nozzles. Plants with similar operating history to Oconee Unit 3, including Davis-Besse, were to inspect their reactor vessel head penetrations by December 31, 2001, or to provide a basis for concluding that there were no cracked and leaking nozzles.

FirstEnergy Nuclear Operating Company requested an extension of the inspection deadline until its refueling outage beginning March 30, 2002, and provided the technical basis for its request. The NRC did not allow the plant to operate until March 30, but agreed to permit operation until February 16, provided that compensatory measures were taken to minimize possible crack growth during the time of operation. The NRC was unaware that nozzle leakage or corrosion had occurred at Davis-Besse when it agreed to the February 16 date.

Barriers Built into Nuclear Plants to Protect Public Health and Safety

The design of every nuclear power plant includes a system of three barriers which separate the highly radioactive reactor fuel from the public and the environment. The Davis-Besse reactor head damage represented a significant reduction in the safety margin of one of these barriers, the reactor coolant system. The reactor coolant system, however, remained intact, as well as the other two barriers, the fuel and the containment.

1. Fuel Pellets and Rods

The first barrier is the fuel itself. The fuel consists of strong, temperature-resistant ceramic pellets made of uranium-oxide. The pellets are about the size of a fingertip. They retain almost all of the highly radioactive products of the fission process within their structure.

The pellets are stacked in a rod made of a zirconium alloy. At Davis-Besse, each fuel rod is about 13 feet long. The rods are assembled into bundles, with each assembly containing 208 rods. The reactor core contains 177 fuel assemblies. Any fission products which escape from the pellets are captured inside the cladding of the rod, which is designed to be leak-tight. Small pin hole leaks do occasionally occur, however, and the operating license requires leakage monitoring and contains limits on the maximum allowable leakage of radioactive materials from the fuel rods.

2. Reactor Coolant System

The second barrier is the reactor coolant system pressure boundary. The reactor core is contained inside the reactor pressure vessel, which is a large steel container. Thick steel pipes supply cooling water to the reactor and carry away the heated water after it passes through the reactor core. The pressure vessel, the connected piping, and other connected components make up the reactor coolant system pressure boundary. At Davis-Besse, the reactor coolant system contains about 60,000 gallons of cooling water, circulated by four large pumps at a rate of about 360,000 gallons per minute.

This system is designed to be leak-tight at operating conditions which include a water temperature of 605° F and a water pressure of 2,150 pounds per square inch. The operating license contains limits on the maximum allowable amount of leakage from the system, and it specifies requirements for monitoring any leakage. If a leak is identified as being through any solid wall of the system (reactor vessel, cooling pipes or other components) continued operation of the plant is prohibited, no matter how small the leak rate.

3. Containment Building

The third barrier is the containment building. This is a large cylindrical building which contains the entire reactor coolant system. None of the piping that contains the high-temperature and high-pressure reactor coolant water extends outside the containment building. The containment is a 1 ½ inch thick steel cylinder, rounded at the top and bottom, which is designed to be leak-tight. This steel structure is surrounded by a reinforced concrete shield building, which is the round building visible from the outside of the plant. Its walls are 2 to 3 feet thick.

NRC's Response to Vessel Head Damage

The NRC responded to the vessel head degradation with a series of actions, some specific to Davis-Besse and others aimed at other PWR plants. The agency directed all PWR licensees to report on the condition of their reactor heads and later specified more stringent examination for inspecting the reactor heads. The NRC also established a Lessons Learned Task Force to review the agency's activities associated with the Davis-Besse reactor head issue.

NRC Davis-Besse Oversight Panel

An NRC Davis-Besse Oversight Panel was created in April 2002 to make sure that all corrective actions, required to ensure that Davis-Besse can operate safely, are taken before the plant is permitted to restart and that Davis-Besse maintains high safety and security standards if it resumes operations. Should the plant restart, the Oversight Panel will evaluate if Davis-Besse's performance warrants reduction of the NRC's heightened oversight and, if so, recommend to NRC management that the plant return to a regular inspection schedule. The panel was established under the agency's Manual Chapter 0350.

The panel brings together NRC management personnel and staff from the Region III office in Lisle, Illinois, the NRC Headquarters office in Rockville, Maryland and the NRC Resident Inspector Office at the Davis-Besse site. The eight-member panel's chair and co-chair are John Grobe, a senior manager from Region III, and William Ruland, a senior manager from NRC headquarters.

The agency will also supplement the resident inspection staff with an additional resident inspector who be at Davis Besse in September, bringing the total staff there to three.

Public Participation in the Process

The NRC's experience is that members of the public, including public officials and citizens, often raise questions or provide insights that are important to consider. If you have questions or want to provide information or a point of view, please contact us. For feedback on this newsletter, contact Viktoria Mitlyng 630/829-9662 or Jan Strasma 630/829-9663 (toll free 800/522-3025 - ext -9662 or -9663). E-mail: opa3@nrc.gov. Extensive information about the Davis-Besse reactor vessel head damage and the ensuing activities is available on the NRC web site: http://www.nrc.gov - select "Davis-Besse" under the list of key topics.